TITLE OF THE INVENTION

IMAGE COMPARISON APPARATUS, IMAGE COMPARISON METHOD, AND PROGRAM FOR CAUSING COMPUTER TO EXECUTE IMAGE COMPARISON

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a Continuation Application of PCT Application No. PCT/JP02/01364, filed February 18, 2002, which was not published under PCT Article 21(2) in English.

This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2001-041931, filed February 19, 2001, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image comparison apparatus and image comparison method which compare a reference image as a sample with a comparison image as a comparison target, and a program for causing a computer to execute image comparison.

2. Description of the Related Art

Recently, many troubles have been caused by counterfeiting of printed matter, counterfeiting of special printing/treatment on ID cards, and the like. Counterfeiting methods associated with such troubles are so sophisticated as to make identification of

counterfeits difficult. In addition, printing or treatment for preventing counterfeiting becomes too elaborate to be checked by the human eye.

Under the circumstances, a comparison microscope like the one shown in FIG. 1 has recently been proposed.

This comparison microscope includes two microscope bodies 202a and 202b. The microscope bodies 202a and 202b respectively have object lenses 203a and 203b. Specimens 204a ad 204b such as printed matter are placed on stages 205a and 205b corresponding to the object lenses 203a and 203b. A common comparison lens barrel 201 is connected to the microscope bodies 202a and 202b. This arrangement allows simultaneous observation of observation images formed by the microscope bodies 202a and 202b through an observation lens barrel 200. For example, the specimen 204a serving as a sample is placed on the stage 205a of the microscope body 202a. The specimen 204b serving as a comparison target is placed on the stage 205b of the microscope body 202b. An observation image of the right half of the specimen 204a in the visual field is abutted against an observation image of the left half of the specimen 204b in the visual field to allow observation of these images as one observation image through the observation lens barrel 200. This makes it possible to compare the left and right observation

images and allow the user to easily check whether or
not the specimens 204a and 204b are identical.

An apparatus using comparison microscopes like
those described above requires a real specimen serving

5   as a sample as well as a specimen serving as a
comparison target for which counterfeit identification
is required. Therefore, an observer who has no
specimen as a sample cannot perform comparing
operation, and has a difficulty in counterfeit

10   identification. In addition, since the two microscope
bodies 202a and 202b are used, variations in brightness
and color between the optical systems of the microscope
bodies 202a and 202b sometimes make it difficult to
compare a comparison image with a reference image.

15   It is important for counterfeit identification to
facilitate recognition of the difference between images
by positioning them for comparison. Such positioning,
however, requires cumbersome operation, e.g., moving
the positions of the specimens 204a and 204b on the

20   stages 205a and 205b.

On the other hand, an image comparison apparatus
for performing comparison and observation using
reference images stored as digital images is known (see
Jpn. Pat. Appln. KOKAI Publication No. 06-6807). In

25   this image comparison apparatus, a plurality of images
captured from a TV camera are stored as digital data.
Subsequently, a half portion of a reference image and a

half portion of a comparison image are extracted and
pasted together to display them as one image on a
monitor. This makes it possible to easily check
whether or not the left and right images are identical.

5   In the above image comparison apparatus, recorded
digital image are read out and compared with each other
on the TV monitor. Since still images that have
already captured (stored) are juxtaposed, a desired
position on a reference image for comparison is

10   difficult to adjust to a comparison image. In
addition, since images are simply arranged side by
side, it is sometimes difficult to observe the
differences between them. When a reference image and
comparison image are to be compared with each other,

15   the same photographing conditions, e.g., a magnifica-
tion, position, and brightness, are preferably set for
these images. When image files obtained by photography
in the past are used for comparison, photographing
conditions cannot often be known. This makes it

20   difficult to accurately compare and observe images.
Assume that an observation window is split into two
parts and two images are displayed therein to be
compared in order to prevent a decrease in resolution.
In this case, half images must be compared with each

25   other, and hence comparison/observation of images must
be performed at least twice. In addition, when an
observation window is split into two parts and images

are displayed therein, the observer may be confused

about which image is a reference image or comparison

image. Furthermore, since differences between two

images are visually checked by the observer, an

5   oversight and the like may occur.

BRIEF SUMMARY OF THE INVENTION

The present invention provides an image comparison

apparatus and image comparison method which can

accurately and efficiently perform comparison and

10   observation of a reference image and a comparison image

with simple operation, and a program which causes a

computer to execute image comparison.

An image comparison apparatus according to the

first aspect of the present invention is characterized

15   by comprising observation image capturing means for

capturing at least one of a macroscopic observation

image of a specimen or a microscopic observation image

of the specimen, photographing means for photographing

an observation image captured by the observation image

20   capturing means, recording means for recording a

reference image prepared in advance, and display means

for displaying the observation image photographed by

the photographing means as a comparison image, and also

displaying the reference image recorded on the

25   recording means on the display means so as to allow

comparison between the comparison image and the

reference image.

An image comparison apparatus according to the
second aspect of the present invention is characterized
by comprising a macro-observation unit which captures a
macroscopic observation image of a specimen, a
5   micro-observation unit which captures a microscopic
observation image of the specimen, a stage which moves
the specimen between the macro-observation unit and the
micro-observation unit, a camera which photographs an
observation image of a specimen on the stage which is
10   captured by the macro-observation unit and the
micro-observation unit, optical path switching
means for switching an optical path from the
macro-observation unit or the micro-observation unit to
the camera, a recording medium which records an
15   observation image photographed by the camera as a
reference image, and display means for displaying the
observation image photographed by the camera as a
comparison image and also displaying the reference
image recorded on the recording medium so as to allow
20   comparison between the images.

An image comparison method according to the third
aspect of the present invention is characterized by
comprising capturing at least one of a macroscopic
observation image and a microscopic observation image
25   of a specimen, photographing the captured observation
image, and displaying an entire or part of a comparison
image obtained from the photographed observation image

and an entire or part of a reference image prepared in advance so as to allow comparison therebetween.

An image comparison method according to the fourth aspect of the present invention is characterized by comprising capturing a macroscopic observation image or a microscopic observation image of a specimen, photographing the captured observation image, and displaying an addition image obtained by adding a comparison image obtained from the photographed observation image to a reference image prepared in advance at an arbitrary ratio.

An image comparison method according to the fifth aspect of the present invention is characterized by comprising capturing a macroscopic observation image or a microscopic observation image of a specimen, photographing the captured observation image, and alternately displaying a comparison image obtained from the photographed observation image and a reference image prepared in advance at predetermined time intervals.

An image comparison method according to the sixth aspect of the present invention is characterized by comprising capturing a macroscopic observation image or a microscopic observation image of a specimen, photographing the captured observation image, performing subtraction between the photographed observation image and a reference image prepared in advance, and

performing displaying on the basis of the subtraction result.

An image comparison method according to the seventh aspect of the present invention which is applied to a system in which at least two image comparison apparatuses and an image server capable of storing at least one image are connected through a network capable of data communication is characterized in that in each of the image comparison apparatuses, a reference image used for comparison with a comparison image acquired from a specimen can be read out from the image server through the network.

A computer program product according to the eighth aspect of the present invention is characterized by capturing at least one of a macroscopic observation image and a microscopic observation image of a specimen, photographing the captured observation image, and displaying an entire or part of a comparison image obtained from the photographed observation image and an entire or part of a reference image prepared in advance so as to allow comparison therebetween.

A computer program product according to the ninth aspect of the present invention is characterized by capturing a macroscopic observation image or a microscopic observation image of a specimen, photographing the captured observation image, and displaying an addition image obtained by adding a

comparison image obtained from the photographed observation image to a reference image prepared in advance at an arbitrary ratio.

A computer program product according to the 10th aspect of the present invention is characterized by capturing a macroscopic observation image or a microscopic observation image of a specimen, photographing the captured observation image, and alternately displaying a comparison image obtained from the photographed observation image and a reference image prepared in advance at predetermined time intervals.

A computer program product according to the 11th aspect of the present invention is characterized by capturing a macroscopic observation image or a microscopic observation image of a specimen, photographing the captured observation image, performing subtraction between the photographed observation image and a reference image prepared in advance, and performing displaying on the basis of the subtraction result.

A computer program product according to the 12th aspect of the present invention which is applied to a system in which at least two image comparison apparatuses and an image server capable of storing at least one image are connected through a network capable of data communication, characterized in that in each of

the image comparison apparatuses, a reference image used for comparison with a comparison image acquired from a specimen can be read out from the image server through the network.

An image comparison method according to the 13th aspect of the present invention is characterized in that a display window designated by a control apparatus connected, through a network capable of data communication, to an apparatus including photographing means for photographing an observation image of a specimen, display means for comparing the photographed observation image, and means for communicating a display method for image comparison is displayed by communication.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. 1 is a view showing the schematic arrangement of a conventional comparison microscope;

FIG. 2 is a block diagram showing a microscopic image comparison apparatus according to the first embodiment of the present invention;

FIG. 3 is a view showing the system arrangement of the microscopic image comparison apparatus according to the first embodiment;

FIG. 4 is a view showing a display example on a monitor used in the first embodiment;

FIGS. 5A to 5F are views showing the first display example for comparison between a reference image and a

comparison image in the first embodiment;

FIGS. 6A to 6F are views showing the second display example for comparison between a reference image and a comparison image according to the first aspect;

FIGS. 7A to 7D are views showing the third display example for comparison between a reference image and a comparison image according to the first embodiment;

FIG. 8 is a flow chart for explaining overlap processing in the first embodiment;

FIG. 9 is a view showing the fourth display example for comparison between a reference image and a comparison image in the first embodiment;

FIGS. 10A to 10C are views showing the fifth display example for comparison between a reference image and a comparison image in the first embodiment;

FIG. 11 is a view showing a display example for comparison between a reference image and a comparison image in the second embodiment of the present invention;

FIG. 12 is a view showing the schematic arrangement of the third embodiment of the present invention;

FIG. 13 is a view showing the system arrangement of a microscopic image comparison apparatus according to the fourth embodiment of the present invention;

FIG. 14 is a view showing a display example on a

monitor used in the fourth embodiment;

FIG. 15 is a flow chart for explaining the operation of the fourth embodiment;

FIG. 16 is a flow chart for explaining the operation of the fourth embodiment; and

FIG. 17 is a flow chart for explaining the operation of the fourth embodiment.

DETAILED DESCRIPTION OF THE INVENTION

The embodiments of the present invention will be described below with reference to the several views of the accompanying drawing.

(First Embodiment)

FIG. 2 is a block diagram showing a microscopic image comparison apparatus as an embodiment of an image comparison apparatus according to the present invention.

Referring to FIG. 2, an observation device 1 for observing a specimen (not shown) includes a micro-observation unit 2 which serves as a micro-observation image capturing means for capturing a microscopic observation image of the specimen so as to capture a microscopic observation image, a macro-observation unit 3 which serves as a macro-observation image capturing image for capturing a macroscopic observation image of the specimen, and a TV camera 4 serving as a photographing means. The observation device 1 sends out the observation image

captured by the micro-observation unit 2 or macro-observation unit 3, as a digital image, to a personal computer body 5 serving as a control means through the TV camera 4.

5 The personal computer body 5 includes an image input board 6, video card 7, RAM 8, CPU 9, recording medium 10, interface 11, and bus 12. The personal computer body 5 stores, in the RAM 8, the digital image captured from the TV camera 4 into the image input

10 board 6, or displays the image as a still or live image on a personal computer monitor 13 serving as a display means through the video card 7 (a live image is displayed at the video rate of the TV camera 4). A plurality of digitalized reference images which are

15 prepared in advance are recorded on the recording medium 10. A program 10a such as image comparison software is also recorded on the recording medium 10. The program 10a is temporarily recorded on the RAM 8 and executed by the CPU 9 to perform image comparison

20 processing. A keyboard 14 and mouse 15 are connected to the interface 11. The keyboard 14 and mouse 15 are used to input instructions when the program 10a is to be executed.

FIG. 3 is a view showing the system arrangement of

25 the microscopic image comparison apparatus in FIG. 2. The same reference numerals as in FIG. 3 denote the same parts in FIG. 2.

Referring to FIG. 3, the micro-observation unit 2
is used as a micro-observation image capturing means
for observation of elaborate printing and treatment of
a specimen upon enlarging it. The micro-observation
unit 2 has an object lens 21 opposed to the specimen
(not shown) placed on a base 20. An elaborate printing
or treatment state of the specimen is enlarged through
the object lens 21 and can be visually observed through
an eyepiece 22. This state is sensed by the TV camera
4 and captured into the personal computer body 5.

The micro-observation unit 2 includes a
polarization illumination source 23, epi-illumination
source 24, transmitted illumination source 25,
epi-fluorescence illumination source 26, and focal
illumination source 27. The polarization illumination
source 23 irradiates the specimen placed on the base 20
with polarized illumination light along the optical
axis through the object lens 21. The epi-illumination
source 24 is so placed as to irradiate the specimen
with light from a position located outside the optical
axis of the object lens 21. The transmitted
illumination source 25 emits light from the inside of
the base 20 toward the object lens 21 to allow
observation of the outer shape of the specimen or
an image transmitted through the specimen. The
epi-fluorescence illumination source 26 is an
illumination source for observation of a fluorescent

image.   This illumination source makes it possible
to observe a special print obtained by applying
fluorescent printing to the specimen.   The focal
illumination source 27 is placed at a position where
the specimen can be obliquely illuminated with light.
This illumination source is used to observe special
treatment of producing an embossed pattern on the
specimen, e.g., imprinting on the specimen.

A micro control box 28 is used to turn on/off the
polarization illumination source 23, epi-illumination
source 24, transmitted illumination source 25,
epi-fluorescence illumination source 26, and focal
illumination source 27 and adjust their brightness.

The macro-observation unit 3 is used as a
macro-observation image capturing means for observing
the specimen in a relatively wide visual field and
range.   The macro-observation unit 3 has a macrolens 29
opposed to the specimen (not shown) placed on a base
281.   An image of the specimen is guided to the optical
path on the micro-observation unit 2 side through the
macrolens 29 and a macro focusing handle 36.   The image
of the specimen guided to the optical path on the
micro-observation unit 2 side can be visually observed
through the eyepiece 22.   This image is also sensed by
the TV camera 4 and captured in the personal computer
body 5.

The macro-observation unit 3 includes, as

illumination devices, a polarization illumination source 30, epi-illumination source 31, transmitted illumination source 32, epi-fluorescence illumination source 33, and focal illumination source 34. The polarization illumination source 30 irradiates the specimen placed on the base 281 with polarized illumination light along the optical axis through the macrolens 29. The epi-illumination source 31 is so placed as to irradiate the specimen with light from a position located outside the optical axis of the macrolens 29. The transmitted illumination source 32 emits light from the inside of the base 281 toward the macrolens 29 to allow observation of the outer shape of the specimen or an image transmitted through the specimen. The epi-fluorescence illumination source 33 is an illumination source for observation of a fluorescent image. This illumination source makes it possible to observe a special print obtained by applying fluorescent printing to the specimen. The focal illumination source 34 is placed at a position where the specimen can be obliquely illuminated with light. This illumination source is used to observe special treatment of producing an embossed pattern on the specimen, e.g., imprinting on the specimen.

A macro control box 35 is used to turn on/off the polarization illumination source 30, epi-illumination source 31, transmitted illumination source 32,

epi-fluorescence illumination source 33, and focal illumination source 34 and adjust their brightness.

FIG. 4 shows an example of a GUI (Graphical User Interface) 41 displayed when the image comparison software of the program 10a recorded on the recording medium 10 is activated. For example, the GUI 41 is displayed as a Windows dialog using an operation system such as Windows of Microsoft.

The GUI 41 has a still image display area 42 serving as the first image display area and a live image display area 43 serving as the second image display area. A digital image as a still image can be displayed as a reference image in the still image display area 42. In this case, the reference image may be an image obtained by photographing a text letter or a counterfeit portion of a print specimen, or an image obtained by photographing, with the TV camera 4, a micro-observation image or macro-observation image of the specimen captured by the micro-observation unit 2 or macro-observation unit 3. These reference images are recorded in advance on the recording medium 10 of the personal computer body 5. A live image serving as a comparison image can be displayed in the live image display area 43. A comparison image is an image of a specimen with which the user wants to compare a reference image (or which is to be compared with the reference image). The comparison image is a live

image (or still image) obtained by photographing, with the TV camera 4, the micro-observation image or macro-observation image of the specimen which is captured by the micro-observation unit 2 or macro-observation unit 3. In this case, an image which is photographed by the TV camera 4 to obtain a comparison image may be an image obtained from either the micro-observation unit 2 or the macro-observation unit 3. The observer can arbitrarily select one of these images which is to be observed, in accordance with a purpose. The live image display area 43 allows a live image to be displayed. However, after the specimen is moved and its observation position is determined, the image in this area can also be temporarily displayed as a still image.

The GUI 41 has an observation image display area 44 as the third image display area. In the observation image display area 44, the still and live images displayed in the still image display area 42 and live image display area 43 can be displayed by various display methods to be described below.

FIGS. 5A to 10C are views for explaining various display examples in the observation image display area 44.

FIGS. 5A to 5F show the first display example in a case wherein the reference image in the still image display area 42 and the comparison image in the live

image display area 43 are placed side by side in the

observation image display area 44. FIG. 5A is a view

showing the reference image in the still image display

area 42. The left half of this image is a left still

5   image portion 42L, and the right half is a right still

image portion 42R. FIG. 5B is a view showing the

comparison image in the live image display area 43.

The left half of this image is a left live image

portion 43L, and the right half is a right live image

10   portion 43R.

FIG. 5C is a view showing an observation image in

the observation image display area 44. A reference

image of the left still image portion 42L is displayed

as the left half of the observation image, and a

15   comparison image of the right live image portion 43R is

displayed as the right half of the observation image.

Likewise, referring to FIG. 5D, a comparison image of

the right live image portion 43R is displayed in the

left half of the area, and a comparison image of the

20   right live image portion 43R is displayed in the right

half of the area. Likewise, referring to FIG. 5D, a

comparison image of the right live image portion 43R is

displayed in the left half of the area, and a reference

image of the left still image portion 42L is displayed

25   in the right half of the area. Likewise, referring to

FIG. 5E, a comparison image of the left live image

portion 43L is displayed in the left half of the area,

and a reference image of the right still image portion
42R is displayed in the right half of the area.
Likewise, referring to FIG. 5F, a reference image of
the right still image portion 42R is displayed in the
left half of the area, and a comparison image of the
left live image portion 43L is displayed in the right
half of the area. In this case, as the left live image
portion 43L and right live image portion 43R, images
photographed by the TV camera 4 are displayed in real
time (at the video rate). This allows the observer to
adjust the left still image portion 42L or right still
image portion 42R to a desired observation position
while moving the specimen. When the observation image
is completely positioned, the left and right images can
be compared as still images.

Referring to FIGS. 5A to 5F, the window is split
into left and right portions at the same ratio.
However, this ratio can be changed. For example,
referring to FIG. 5C, the width of the left still image
portion 42L may be decreased, and the width of the
right live image portion 43R may be increased.

Displaying a reference image and comparison image
side by side in this manner helps the observer to
visually find the difference between an original and a
counterfeit print.

FIGS. 6A to 6F show the second display example in
a case wherein a reference image in the still image

display area 42 and a comparison image in the live
image display area 43 are vertically arranged in the
observation image display area 44 to be compared with
each other. FIG. 6A shows the reference image in the

5   still image display area 42. The upper and lower
halves of this image are an upper still image portion
42U and lower still image portion 42D, respectively.
FIG. 6B shows the comparison image in the live image
display area 43. The upper and lower halves of this

10   image are an upper live image portion 43U and lower
live image portion 43D, respectively.

    FIG. 6C shows the observation image in the
observation image display area 44. The upper half of
the observation image is displayed as a reference image

15   of the upper still image portion 42U; and the lower
half, as a comparison image of the lower live image
portion 43D. Likewise, referring to FIG. 6D, the upper
half is displayed as a comparison image of the lower
live image portion 43D; and the lower half, as a

20   reference image of the upper still image portion 42U.
Referring to FIG. 6E, the upper half is displayed as a
comparison image of the upper live image portion 43U;
and the lower half, as a reference image of the lower
still image portion 42D. Referring to FIG. 6F, the

25   upper half is displayed as a reference image of the
lower still image portion 42D; and the lower half, as a
comparison image of the upper live image portion 43U.

In this case as well, as the upper live image portion
43U and lower live image portion 43D, the images
photographed by the TV camera 4 are displayed in real
time (at the video rate). This allows the observer to
adjust the upper still image portion 42U or lower still
image portion 42D to a desired observation position
while moving the specimen. When the observation image
is completely positioned, the left and right images can
be temporarily compared as still images.

The widows shown in FIGS. 5A to 5F and FIGS. 6A to
6F can be easily switched by clicking a "split display"
icon 45 on the GUI 41.

Displaying a reference image and comparison image
upon vertically arranging them in this manner as well
helps the observer to, for example, visually find the
difference between an original and a counterfeit print.

FIGS. 7A to 7D show the third display example
showing a method in a case wherein a reference image in
the still image display area 42 and a comparison image
in the live image display area 43 are overlapped (image
addition) in the observation image display area 44
to be compared with each other. FIG. 7A shows an
observation image in the observation image display area
44. Referring to FIG. 7A, only a still image 42A which
is a reference image in the still image display area 42
is displayed. FIG. 7B shows an example of an overlap
image 46a. A live image 43B (see FIG. 7D) which is a

comparison image in the live image display area 43 is displayed upon being superimposed on the still image 42A at a predetermined ratio (this processing will be referred to as "overlap processing" hereinafter).

Assume that two images (e.g., images "A" and "B") are added. In this case, letting $Ia(x, y)$ be the luminance of a given pixel (when the pixel position is represented by (x, y) of the image "A", and $Ib(x, y)$ be the luminance of a pixel of the image "B" at the same position, a luminance $I(x, y)$ of the overlap image can be obtained by

$$I(x, y) = Ia(x, y) \times m + Ib(x, y) \times n$$

for $m = 1 - n$; $(0 \leqq m, n \leqq 1)$.

The images are added by performing this calculation for all the pixels. Referring to the overlap image 46a in FIG. 7B, since the ratio of the still image 42A is larger than that of the live image 43B, the still image 42A is seen more clearly. As the ratio of the still image 42A is decreased below that of the live image 43B, the live image 43B is seen more clearly than the still image 42A unlike the overlap image 46a shown in FIG. 7B. That is, as the ratio of the still image 42A is increased, only the still image 42A in FIG. 7A can be seen eventually. As the ratio of the live image 43B is increased, only the live image 43B in FIG. 7D can be seen eventually.

The above overlap processing will be described

with reference to the flow chart shown in FIG. 8.

In step S1, the overlap ratio (the default value
or previously set value) between the still image 42A
and the live image 43B is read out from the recording
medium 10. This overlap ratio corresponds to the ratio
between $\underline{m}$ and $\underline{n}$ in the above equation. Note that the
operator can easily adjust the overlap ratio by moving
a slider 47 on the GUI 41 shown in FIG. 4. In step S2,
the still image 42A and live image 43B are added and
synthesized at the read overlap ratio, and the
resultant image is displayed in the observation image
display area 44. In this case, calculation of a ratio
is performed for all the pixels of the images according
to the above equation. It is then checked in step S3
whether or not the overlap ratio is changed with the
slider. If the overlap ratio is changed with the
slider 47, the value designated with the slider 47 is
set again as an overlap ratio stored in the RAM 8 or
recording medium 10 in step S4.

The flow then returns to step S1 to repeat the
same processing.

If it is determined in step S3 that the overlap
ratio is not changed, the flow advances to step S5 to
check whether the overlap processing is to be
terminated. If the overlap processing is not
terminated, the flow returns to step S3 to repeat the
same processing. If the overlap processing is to be

terminated, a series of operations in the overlap
processing is terminated.

In the above manner, overlap display is performed
by adding and overlapping a reference image and
5   comparison image, e.g., an original and a counterfeit
print, thereby helping the observer to visually find
the difference between them.

FIG. 9 shows the fourth display example in a case
wherein a reference image in the still image display
10   area 42 and a comparison image in the live image
display area 43 are alternately switched and displayed
in the observation image display area 44 at predeter-
mined time intervals to be compared with each other.

In this case, first of all, the reference image
15   displayed in the still image display area 42 is
displayed as a still image 42E in the observation image
display area 44. After a lapse of a predetermined
period of time, the comparison image displayed in the
live image display area 43 is displayed as a live image
20   43F in the observation image display area 44. After
a lapse of a predetermined period of time, the
still image 42E is displayed. Such processing is
continuously executed. A program for this image
switching/display processing can be executed by
25   clicking a predetermined icon on the GUI 41. The image
switching time can be changed to an arbitrary value by
inputting a predetermined time interval through the GUI

41, as described above.

Using the persistence of vision by alternately switching and displaying two images at predetermined time intervals as in animation in this manner helps the observer to, for example, visually find the difference between an original and a counterfeit document.

FIGS. 10A to 10C show the fifth display example in a case wherein different portions of a reference image in the still image display area 42 and a comparison image in the live image display area 43 are highlighted.

An outline of an automatic different portion detection method of detecting a difference portion between a reference image and a comparison image will be described. A different portion is detected by the automatic different portion detection method in the following manner. A still image 43G displayed in the still image display area 42 is compared with a live image 43H displayed in the live image display area 43. On the basis of the comparison result, the different portion is highlighted as a different-portion-emphasized image 43I in the observation image display area 44.

For example, a different portion is automatically detected by subtraction between a reference image and a comparison image. For example, letting Ib(x, y) be the luminance of a given pixel of an image "B", and

Ib'(x, y) be the luminance of a pixel of an image "B'"

at the same position, a luminance I(x, y) of an image

obtained by subtraction can be given by

$$I(x, y) = |Ib(x, y) - Ib'(x, y)|$$

5   In this case, if the luminance I is higher than 0, the

corresponding pixels differ from each other.   In

consideration of noise and the like, however, a

threshold may be set so that when the luminance is

equal to or more than a predetermined value (e.g., 50),

10   it is determined that the corresponding pixels differ

from each other.   Image subtraction can be done by

performing this calculation for all the pixels.

FIG. 10C shows the different-portion-emphasized image

43I in which the different portion between the images

15   in FIGS. 10A and 10B is highlighted.   According to this

different-portion-emphasized image, since an area 48 of

the still image 43G in FIG. 10A differs from the

corresponding portion of the live image 43H in

FIG. 10B, the area 48 can be obtained as a different

20   portion 48A.   As shown in FIG. 10C, in the

different-portion-emphasized image 43I, the area 48A

may be highlighted with a color or graphic pattern so

as to be displayed as the area 48A.   Alternatively, in

the different-portion-emphasized image 43I, only the

25   different area 48A may be displayed, or the different

area may be superimposed and displayed on the still

image 43G, the live image 43H, or an image obtained by

overlapping the still and live images. The ratio of the number of pixels that differ in luminance to the number of pixels of the entire image is obtained. The difference between the images can then be evaluated by regarding the obtained ratio as the degree of coincidence between the images.

The different portion between the still image 43G and the live image 43H is highlighted (automatically or manually) to allow the operator to easily grasp the different portion between the two images. This also makes it possible to automatically determine the presence/absence of a different portion. Therefore, this can prevent variations among operators.

Measures against lack of brightness of the live image 43H will be described below. When an image lacks in brightness, illumination may be adjusted to increase the brightness of the image as described in FIG. 3. Even if, however, the intensity of illumination is maximized, the image may still be dark. When a fluorescent image is to be observed, in particular, the image becomes very dark. In such a case, integration processing is preferably performed with respect to the live image 43H. For example, this integration processing is performed as follows. Analog images photographed by the TV camera 4 shown in FIG. 2 are sequentially converted into digital images at the video rate by the image input board 6. The sequentially

converted digital images are added when they are
temporarily stored in a storage device (not shown) in
the video card 7. The added digital images are
sequentially displayed as the live image 43H on the
5   personal computer monitor 13. In the integration
processing, sequentially converted digital images are
stored in the storage device while being added one by
one. This makes it possible to increase the luminance
of the image. In addition, as digital images are
10   added, flickering noise pixels in an image are averaged
to form a smooth image. That is, the noise in the
image is reduced.

As described above, an observation image captured
by the macro-observation unit 3 for capturing a
15   macroscopic observation image of a specimen or the
micro-observation unit 2 for capturing a microscopic
observation image of a specimen is photographed by the
TV camera 4. A comparison image formed from the
photographed observation image and a reference image
20   prepared in advance are displayed on the personal
computer monitor 13 by various display methods so as to
be compared with each other. This makes it possible to
easily and efficiently compare and observe a specimen,
e.g., special printing on printed matter or ID card.

25   In addition, various kinds of illumination methods
can be selectively used in accordance with specimens.
This helps the observer to visually observe a print or

treatment which is difficult to see, thereby realizing high-precision image comparison.

Photographing conditions and the like set when a reference image is captured are preferably stored. Since this allows a comparison image to be captured under the same photographing conditions, there is no sense of congruity between the images to be compared with each other. Therefore, high-precision image comparison can be done.

Furthermore, since a mode suitable for specimens to be compared can be selected from a plurality of image comparison modes (e.g., the first to fifth display examples), image comparison can be performed under optimal conditions.

Moreover, for example, as in the fifth display example, a different portion between two images can be highlighted with a color or mark on an image display to attract the attention of the observer. This facilitates visual recognition of the difference between the images.

In the first embodiment, printed matter or the like has been described as a specimen. However, a specimen is not limited to printed matter and includes anything that can be stored as a digital image, e.g., a virus or organic cell that can be observed with a microscope.

(Second Embodiment)

The second embodiment of the present invention will be described with reference to FIG. 11.

The apparatus arrangement and GUI in the second embodiment are the same as those described in the first embodiment with reference to FIGS. 2, 3, and 4, and hence a description thereof will be omitted.

FIG. 11 shows an observation image displayed in an observation image display area 44 of a GUI 41 in FIG. 4. Referring to FIG. 11, a lattice 51 with a predetermined spacing is displayed on the observation image in the observation image display area 44. The lattice 51 may have a 9 × 6 matrix as shown in FIG. 11 and can be arbitrarily changed to, for example, a 2 × 2 matrix. With this arrangement, when a reference image in a still image display area 42 and a comparison image in a live image display area 43, which are described in the first embodiment, are displayed side by side, graphic patterns of the two images which are to be compared, the sizes of printed characters, positional relationships, and the like can be visually compared with each other easily. This allows the observer to easily find the difference between the two images.

(Third Embodiment)

The third embodiment of the present invention will be described with reference to FIG. 12.

When the above microscopic image comparison

apparatus is used on a standalone basis, an image or
information about a counterfeit print or the like as a
specimen can be used in only this apparatus. Even if,
therefore, for example, suspicious objects such as

5   counterfeit prints are found in different places, e.g.,
various regions, it cannot be checked whether or not
they are identical counterfeit prints. In addition, an
image of an original print or the like must be captured
in advance as a digital image in each microscopic image

10   comparison apparatus by carrying an original specimen
to each region. Such operation must be performed for
all the microscopic image comparison apparatuses, and
hence it takes much time, resulting in poor operation
efficiency.

15   In the third embodiment, therefore, a plurality of
microscopic image comparison apparatuses are connected
to each other through a network.

        Assume that as a plurality of microscopic image
comparison apparatuses, a microscopic image comparison

20   apparatus A61 in Tokyo, a microscopic image comparison
apparatus B62 in Osaka, and a microscopic image
comparison apparatus C63 in Fukuoka are installed in
the respective regions. Personal computer bodies 5 of
the microscopic image comparison apparatus A61,

25   microscopic image comparison apparatus B62, and
microscopic image comparison apparatus C63 are
connected to a network 64 through network interfaces

(not shown). The network 64 can be a dedicated line such as an ISDN or the Internet. An image server 65 is connected to the network 64. The image server 65 can perform data communication with the microscopic image

5 comparison apparatus A61, microscopic image comparison apparatus B62, and microscopic image comparison apparatus C63.

In the above arrangement, necessary digital images and associated information, e.g., a description of a

10 counterfeit portion of a document, are stored in the image server 65 in advance. Assume that a thing suspected as a counterfeit is found in an Osaka region. In this case, an operator uses the personal computer body 5 of the microscopic image comparison apparatus

15 B62 in Osaka to search the image server 65 for information about the thing suspected as the counterfeit and download necessary information through the network 64. The operator then performs image comparison.

20 Every time an image or information of a counterfeit is found in a region, the image or information is stored in the image server 65. This makes it possible to obtain information about the counterfeit in real time. In addition, when such new

25 information is stored in the image server, the image sever may automatically send a message or the like to each of the microscopic image comparison apparatuses

61, 62, and 63 so as to allow an operator in each region to always receive the latest information.

As described above, when a plurality of microscopic image comparison apparatuses are installed in various regions, they are connected to each other through the network 64 and allowed to perform data communication using the image server 65. This allows a plurality of microscopic image comparison apparatuses to share image data and other information. This makes it possible to perform image comparison using the latest image data collected from various regions. Even if, therefore, things suspected as counterfeit prints or the like are found in various regions, for example, whether or not the things are identical counterfeits can be immediately checked by using the latest information about counterfeits found in other regions. That is, the operation efficiency can be greatly improved.

Note that the third embodiment has exemplified the case wherein image files and the like in the image server are shared through the network. The following arrangement using a network can also be used. An apparatus in each region is used to only photograph an image to be compared and select an image comparison method. These pieces of information are then communicated, through the network, to a control apparatus for centralized data processing. The control

apparatus communicates a display window for image comparison to the apparatus in each region on the basis of the pieces of information. The apparatus in each region may perform image comparison on the basis of the photographed image and the image transmitted from the control apparatus.

(Fourth Embodiment)

The fourth embodiment of the present invention will be described with reference to FIG. 13.

In the first embodiment described above, a specimen on the base 281 is compared with a reference image in a wide visual field by using the macro-observation unit 3. The specimen is transferred onto the base 20 of the micro-observation unit 2 as needed to compare it with the reference image upon enlarging elaborate printing or treatment. In the fourth embodiment, these operations can be automatically performed.

FIG. 13 is a view showing the system arrangement of a microscopic image comparison apparatus according to the fourth embodiment.

Referring to FIG. 13, the microscopic image comparison apparatus includes an observation device 69 and image processing device 70.

The observation device 69 includes a micro-observation unit 71 serving as an integrated micro-observation image capturing means and a

macro-observation unit 72 serving as a macro-observation image capturing means. The micro-observation unit 71 and macro-observation unit 72 have a common macro/micro motor-driven stage (automatic X-Y stage) 75 on a base (for micro observation) 73 and a base (for macro observation) 74. A specimen can be automatically transferred between the micro-observation unit 71 and the macro-observation unit 72 by driving the macro/micro motor-driven stage 75.

A TV camera 76 is provided for the micro-observation unit 71 and macro-observation unit 72 to photograph observation images in these units. In the micro-observation unit 71, the TV camera 76 photographs a specimen through a micro/macro zoom handle 77 and object lens 78. In this case, focus adjustment is performed by using a micro focusing handle 79. In the macro-observation unit 72, the TV camera 76 photographs a specimen through the micro/macro zoom handle 77, an optical path switching device (not shown), and a macrolens 80. In this case, focus adjustment is performed by using a macro focusing handle 81.

In this case, the micro focusing handles 79 and 81 of the micro-observation unit 71 and macro-observation unit 72, a dimmer (not shown), the optical path switching device (not shown), and the TV camera 76 can be automatically controlled by a personal computer body 82 serving as a control means which is a part of the

image processing device 70.

The micro-observation unit 71 and macro-observation unit 72 have various kinds of illumination sources. The micro-observation unit 71 has a

5 polarization illumination source 83, epi-illumination source 84, epi-fluorescence illumination source 85, focal illumination source 86, transmitted illumination source 87, and infrared transmitted illumination source 88. The macro-observation unit 72 has a polarization

10 illumination source 89, epi-illumination source 90, epi-fluorescence illumination source 91, focal illumination source 92, transmitted illumination source 93, and infrared transmitted illumination source 94. These illumination devices are selected by the personal

15 computer body 82, a micro control box (manual operation box) 95, and a macro control box (manual operation box) 96 in accordance with illumination methods suitable for the observation regions of specimens to be compared and the like.

20 Note that an eyepiece 97 is a lens for direct visual observation of an observation image of a specimen which is obtained by the micro-observation unit 71 or macro-observation unit 72.

The observation device 69 is connected to the

25 image processing device 70 through a macro/micro communication cable 98, camera video cable 99, and TV camera communication cable 100.

In addition to the personal computer body 82, the image processing device 70 includes a personal computer monitor 101 serving as a display means for displaying an observation image, a GUI for control, and the like,

5 and an keyboard 102 and mouse 103 as input devices. The image processing device 70 controls the observation device 69 through the macro/micro communication cable 98. The image processing device 70 captures a video signal from the TV camera 76 through the camera video

10 cable 99. The image processing device 70 also controls the brightness, contrast, and the like of the TV camera 76 through the TV camera communication cable 100. That is, the image processing device 70 captures, in the video card 7, an image sensing signal from the TV

15 camera 76 through the image input board 6 in the personal computer body 82, and displays the signal as a digital image on the personal computer monitor 101.

The personal computer monitor 101, keyboard 102, and mouse 103 are connected to the personal computer

20 body 82. The personal computer monitor 101 displays a menu for system control, buttons, and images. The keyboard 102 and mouse 103 are used to operate the menu and buttons.

The personal computer body 82 has a frame memory

25 function for displaying an image photographed by the TV camera 76, a menu/button operation function for system control, a communication function for controlling the

observation device 69, and the like. The personal
computer body 82 further includes a memory function for
temporarily storing image data. The personal computer
body 82 also includes a communication means (e.g.,

5   Ethernet, GP-IB, Parallel, and Serial) required to make
other personal computers (servers, peripheral devices,
or the like) store data such as an image photographed
by the TV camera 76 and photographing conditions so as
to share the data and to exchange data with other

10   personal computers (servers, peripheral devices, or the
like). In addition, the personal computer body 82
outputs, to the observation device 69 through
interfaces, an instruction to drive the macro/micro
motor-driven stage 75, focus, zoom, optical path

15   switching, illumination method switching, and
brightness control instructions, an instruction to
control the TV camera 76, and the like. The interfaces
are incorporated in the observation device 69 and
personal computer body 82 and include, for example,

20   RS-232C, GP-IB, Parallel, Serial, and SCSI.

The operation of the fourth embodiment having the
above arrangement will be described with reference to
FIGS. 14 to 17.

FIG. 14 shows a display example on the personal

25   computer monitor 101. FIGS. 15 to 17 are flow charts
for explaining operation procedures and operation.

First of all, a reference image serving as a

reference for image comparison is acquired and registered (steps S11 to S23 to be described later).

In step S11 shown in FIG. 15, the observer selects an observation unit in the observation device 69. That is, the observer selects the macro-observation unit 72 or micro-observation unit 71 depending on the size of an observation area on a specimen or the like. In this case, the observer switches the optical paths by clicking a macro button 106 or micro button 107 corresponding to the macro-observation unit 72 or micro-observation unit 71 on an operation window 105 on the monitor shown in FIG. 14, thereby selecting a desired observation unit (steps S12 and S13). The observer then selects a live image button 108a on the operation window 105 on the monitor to display the live image photographed by the TV camera 76 in an observation image display area 109 (step S14). In this case, the image photographed by the TV camera 76 can be displayed as a still image in the observation image display area 109 by selecting a freeze button 134.

The observer then sets a specimen serving as a sample for generating a reference image on the macro/micro motor-driven stage 75 on the selected observation unit side (step S15). The observer selects an illumination source suitable for the specimen by using the macro control box 96 or micro control box 95 and adjusts the brightness while looking at the live

image (observation image) displayed in the observation image display area 109 (step S16).

The observer determines whether to enlarge and observe a minute portion of the observation image (step S17). If the observer wants to enlarge the minute portion of the observation image (YES), he/she sets a magnification with a magnification change button 110. The observer then moves the pointer of the mouse 103 onto the observation image. As a consequence, a capture area with the magnification designated with the pointer is displayed on the observation image. The observer clicks a desired capture position to determine an enlargement position (step S18), and clicks a setting button 111 on the operation window 105. With this operation, the personal computer body 82 calculates the central position of the image to be enlarged from the current stage position, the set magnification, and the position of the mouse point on the observation image. The personal computer body 82 then automatically moves the macro/micro motor-driven stage 75 to make the central position of the image to be enlarged coincide with the optical axis of the selected observation unit. With this operation, a desired observation position on the specimen is set (step S19).

The observer adjusts a zoom magnification so as to display a desired observation area of the specimen, and

makes focus adjustment (step S20).

If it is determined in step S17 that the minute portion of the observation image is not enlarged, the flow immediately advances to step S20. The observer then adjusts a zoom magnification so as to display a desired observation area of the specimen, and makes focus adjustment.

The observer determines whether or not the contrast of the observation image is sufficient (step S21). If the fluorescence illumination source or specimen is low, a clear reference image cannot be generated. Hence, high-precision image comparison cannot be done. In this case, image integration processing is performed (step S22).

In this case, first of all, the observer selects an automatic contrast button 112 on the operation window 105 to perform automatic contrast processing. With this operation, the personal computer body 82 performs gain or offset adjustment to set an optimal luminance level for the captured image, and changes the image data. The personal computer body 82 then displays the resultant image in the observation image display area 109 again. The observer adjusts the observation position, magnification, and focus of the specimen while looking at this image. The observer selects an integration button 113 on the operation window 105 to start image integration processing. With

this operation, the personal computer body 82 stores

captured images by a set image count, adds the image

data, and displays the resultant image in the

observation image display area 109 again. The observer

5   adjusts the number of times of integration by setting

an integration count 114 on the operation window 105 in

accordance with the brightness of the specimen, thus

adjusting the image to facilitate observation.

When these preparations are finished, an image

10   registration button 115 on the operation window 105 on

the monitor is operated to register the displayed image

as a reference image (step S23). In this case, the

personal computer body 82 captures a video signal from

the TV camera 76 in the form of a digital image through

15   the image input board 6, and stores it as a reference

image in a storage medium 10. In addition, the

personal computer body 82 displays this image in a

still image display area 116. The personal computer

body 82 also checks photographing conditions set at

20   this time through communication with the observation

device 69 and TV camera 76, and records the conditions

on a photographing condition file in the personal

computer body 82. This communication is performed

through the macro/micro communication cable 98 and TV

25   camera communication cable 100.

In registering a reference image, reference image

data may be read out from the personal computer body 82

or from a recording medium in another personal computer through a communication means such as a network and registered by selecting a file read button 117 on the operation window 105. In this case, the procedure in steps S11 to S23 is not required. Alternatively, the procedure from step S11 to step S23 may be automated where possible regardless of operation by the observer.

An observation image of a specimen to be compared is acquired and compared with the reference image (steps S24 to S42 to be described later). The observer sets a sample specimen for comparison from which a comparison image is to be generated in placed of the sample specimen for the generation of a reference image which is set on the macro/micro motor-driven stage 75 (step S24). The observer then selects a photographing condition button 118. As a consequence, the personal computer body 82 reads out the photographing condition file formed when the reference image was registered, and performs automatic control on the observation device 69 side through the macro/micro communication cable 98 so as to, for example, position the macro/micro motor-driven stage 75, select a zoom magnification and an illumination method, perform brightness control, and set the TV camera 76. This makes observation conditions coincide with the conditions set when the reference image was acquired. A live image of an observation image photographed by

the TV camera 76 is then displayed in the observation image display area 109.

Note that even if photographing operation is performed under the same photographing conditions, a difference in tint or the like may occur between images owing to errors caused in the micro-observation unit 71 and macro-observation unit 72 by deterioration in the quality of the lamps of illumination devices, lenses, and the like. The personal computer body 82 therefore performs color adjustment in the image input board so as to make the reference image and comparison image coincide with each other in terms of color reproduction. For example, the personal computer body 82 performs color adjustment in the image input board to make the reference image coincide with the comparison image in terms of luminance information of red, green, and blue as color information of a feature point and background.

The observer then checks from the displayed observation image display area 109 whether or not an area of the specimen which he/she wants to observe is displayed, and adjusts the zoom magnification and focus (step S25).

The observer checks whether or not the contrast of the image is sufficient (step S26). If the contrast of fluorescence illumination or the specimen is low, the image cannot be made clear without any processing in

subsequent observation. In this case as well, image integration processing is performed (step S27).

First of all, the observer selects the automatic contrast button automatic contrast button 112 on the operation window 105 of the monitor to perform automatic contrast processing. With this operation, the personal computer body 82 performs gain or offset adjustment to set an optimal luminance level for observation of the captured image, and changes the image data. The personal computer body 82 then displays the resultant image in the observation image display area 109 again. The observer adjusts the observation position, magnification, and focus of the specimen while looking at this image. The observer selects the integration button 113 on the operation window 105 to start image integration processing. With this operation, the personal computer body 82 stores captured images by a set image count, adds the image data, and displays the resultant image in the observation image display area 109 again. The observer adjusts the number of times of integration by setting the integration count 114 on the operation window 105 in accordance with the brightness of the specimen, thus adjusting the image to facilitate observation. Note that the acquisition and display of an observation image in steps S24 to S27 can be automated as in the case of the acquisition of a reference image.

With this operation, the photographing conditions
for a reference image are made to coincide with those
for a comparison image. This makes it possible to
photograph images that can be easily compared with each
other. The processing of comparing the images is then
started.

Referring to FIG. 17, the observer selects an
image comparison mode suitable for the specimens from
"split image display", "overlap display", and "image
switching display" on the operation window on the
monitor (step S28). With this selection of the image
comparison mode, an image from the TV camera 76 is
displayed as a comparison image in a live image display
area 119.

In split image display as the first image
comparison mode, the observation image display area 109
is split into two upper and lower or left and right
areas, so that a reference image formed from a still
image is displayed in one split area, and a comparison
image formed from a moving or still image is displayed
in the other split area. Upon selection of this split
mode, a display method for split image display is
selected (step S29). The display methods for split
image display include: "left: reference image · right:
comparison image", "left: comparison image · right:
reference image", "upper: reference image · lower:
comparison image", and "upper: comparison

image·lower: reference image". These methods can be selected by buttons 120. Note that a ruled line serving as a boundary line that splits the area can be moved with ruled line moving buttons 133.

5   The observer selects a display method for split image display which is suitable for areas of specimens which are to be compared with each other. In this case, a vertical scroll bar 121 and horizontal scroll bar 122 are arranged for the reference image displayed

10   in one split area of the observation image display area 109. The display position of the reference image is adjusted by moving the scroll bars (step S30). In this case, the personal computer body 82 automatically moves the macro/micro motor-driven stage 75 in accordance

15   with the movement amounts of the scroll bars so as to make the image display position of the reference image coincide with that of the comparison image. A live image is displayed as a comparison image displayed in the other split area of the observation image display

20   area 109. If the observer wants to finely adjust the position of the comparison image as needed, he/she adjusts the display position of the comparison image by moving the macro/micro motor-driven stage 75 while checking the image.

25   In overlap display as the second image comparison mode, the image obtained by multiplying the luminance ratio between a reference image and a comparison image

by m/n where $\underline{n}$ and $\underline{m}$ are arbitrary integers (n ≥ m) is added to the image obtained by multiplying the luminance ratio by (n - m)/n, and the resultant image is displayed in the observation image display area 109,

5 thereby allowing the observer to observe an image having the reference image and comparison image seen through each other. Note that when the luminance ratio between the reference image and the comparison image is gradually changed by changing the integers $\underline{n}$ and $\underline{m}$, one

10 of the images can be emphasized and displayed.

In this case, the observer selects an overlap button 123 (step S31), and adjusts the positions of the reference image and comparison image (step S32), thus eliminating the slight positional error between the

15 reference image and the comparison image by moving the macro/micro motor-driven stage 75 while checking the overlap image. The observer checks the overlap image to find a mismatch. In adjustment of a display ratio (step S33), if the observer wants to emphasize one of

20 the images, he/she changes a display ratio adjustment bar 124. This makes it possible to increase the display ratio of one of the images and display the resultant image.

In image switching display (animation) as the

25 third image comparison mode, two images, i.e., a reference image and comparison image, are repeatedly and alternately switched and displayed in the

observation image display area at predetermined time
intervals. The observer selects the overlap button 123
in advance (step S34) and adjusts the positions of the
reference image and comparison image (step S35), thus

5   eliminating the slight positional error between the
reference image and the comparison image. The observer
then selects an image switching display (animation)
button 125 (step S36), and checks a mismatch while
checking the switched images. That is, the observer

10   recognizes a different portion by the persistence of
vision by alternately switching the images. In this
case, the observer sets a switching time (step S37) to
observe the images upon setting a switching time
suitable for comparison by operating the internal

15   electrode 126.

Note that an up/down button 127, left/right button
128, and negative button 129 are arranged in the still
image display area 116 to change the display method for
a reference image. When, for example, the states of

20   the upper and lower surfaces of a specimen are to be
compared with each other, the reference image can be
vertically and horizontally reversed by using the
up/down button 127 and left/right button 128 so as to
make the direction of the image photographed from the

25   lower surface side coincide with the direction of the
image photographed from the upper surface side.
Depending on specimens, positive/negative reversal of

an image on one side by means of the negative button 129 facilitates recognition of image comparison.

When image comparison is completed, the observer selects an automatic foreign object detection button

5   130. As a consequence, in automatic foreign object detection processing (step S38), the personal computer body 82 compares binary images of the reference image and comparison image, and colors a different portion or displays it with a mark or the like, thereby supporting

10   image comparison by the observer. The observer then visually observes the images and compares the images with each other upon referring to the automatic foreign object detection processing (step S39).

When the observer selects a comment button 131, a

15   drawing function allows the observer to input a comment on a reference image, a comparison image, or a observation image in the image comparison mode (step S40). The observer then adds a supplementary remark. When the observer causes an image required to be stored

20   to be displayed in the observation image display area 109 and selects an image storage button 132, the image is stored in a desired storage medium (step S41). At this time, the personal computer body 82 also stores observation conditions for the stored image.

25   Subsequently, the observer determines whether to continue detailed comparison observation upon changing the observation portions of the specimens (step S42).

If comparison observation is to be continued, the flow returns to step S11 to repeat the above operation. If comparison observation is not to be continued, the observation is finished.

With this operation, the observer can easily compare and observe a reference image and comparison image upon making the characteristic portions of the specimens more clear by using the micro-observation unit 71, the macro-observation unit 72, various kinds of illumination devices, and the respective image comparison modes.

In addition, the observer can observe a reference image stored in advance and a comparison image that is being photographed by the micro-observation unit 71 or macro-observation unit 72 under the same observation conditions as those in the past. The observer can also easily compare and observe a characteristic feature of a specimen observed in the past and a characteristic feature of a currently observed specimen under the same conditions.

The observation conditions set when an image is stored are stored together with image data. If, for example, the observation conditions are stored in a shared storage medium, the same observation conditions as those set when image comparison was performed by using images used in the past can be automatically set in any system, thereby greatly improving the efficiency

of reexamination.

Assume that the observer wants to continue observation upon changing the magnification and positions. In this case, when the observer designates a magnification and positions, the macro/micro motor-driven stage 75 automatically moves to the observation position, and the magnification changes. This makes it possible to easily set observation positions of the reference image and comparison image and a magnification. The use of various kinds of image comparison modes facilitates comparison between a reference image and a comparison image. This allows the observer to easily find the difference between the images. In addition, this makes it possible to perform high-precision image comparison.

Each embodiment described above has exemplified the case wherein both the micro-observation unit 2 and the macro-observation unit 3 are prepared as means for capturing observation images of specimens. Obviously, however, the present invention can be realized even by using only one of the micro-observation unit 2 and macro-observation unit 3.

Note that the embodiments of the present invention incorporate the following programs and recording medium on which the programs are recorded:

(1) A computer-readable recording medium storing a program for capturing a macroscopic or microscopic

observation image of a specimen, photographing the captured observation image, and displaying an entire or part of a comparison image obtained from the photographed observation image and an entire or part of a reference image prepared in advance so as to allow comparison therebetween.

(2) In description (1), a computer-readable recording medium storing a program for displaying at least the comparison image in the form of a live image.

(3) A computer-readable recording medium storing a program for capturing a macroscopic or microscopic observation image of a specimen, photographing the captured observation image, adding a comparison image obtained from the photographed observation image and a reference image prepared in advance at an arbitrary ratio, and displaying the resultant image as an addition image.

(4) A computer-readable recording medium storing a program for capturing a macroscopic or microscopic observation image of a specimen, photographing the captured observation image, and alternately displaying a comparison image obtained from the photographed observation image and a reference image prepared in advance at predetermined time intervals.

(5) In any one of descriptions (1) to (4), a computer-readable recording medium storing a program for displaying the comparison image obtained from the

observation image while allowing brightness of the image to be adjusted by integration processing.

(6) In any one of descriptions (1) to (4), a computer-readable recording medium storing a program for displaying the comparison image and reference image upon superimposing a lattice with a predetermined spacing on the image.

(7) A computer-readable recording medium storing a program for capturing a macroscopic or microscopic observation image of a specimen, photographing the captured observation image, subtracting a comparison image obtained from the photographed observation image and a reference image prepared in advance, and performing highlighting on the basis of the subtraction result.

As has been described above, according to the present invention, there are provided an image comparison apparatus and image comparison method which can perform comparison observation of a reference image and comparison image by simple operation with high precision and efficiency, and a program for causing a computer to execute image comparison.